WIRELESS INFRARED COMMUNICATIONS FOR SPACE AND TERRESTRIAL APPLICATIONS

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ABSTRACT

Voice and data communications via wireless (and fiberless) optical means has been commonplace for many years. However, continuous advances in optoelectronics and microelectronics have resulted in significant advances in wireless optical communications over the last decade. Wilton has specialized in diffuse infrared voice and data communications since 1979.

In 1986, NASA Johnson Space Center invited Wilton to apply its wireless telecommunications and factory floor technology to astronaut voice communications aboard the Shuttle. In September, 1988 a special infrared voice communications system flew aboard a "Discovery" Shuttle mission as a flight experiment. Since then the technology has been further developed, resulting in a general purpose 2 Mbs wireless voice/data LAN which has being tested for a variety of applications including use aboard Spacelab.

Funds for Wilton's wireless IR development were provided in part by NASA's Technology Utilization Office and by the NASA Small Business Innovative Research Program. As a consequence, Wilton's commercial product capability has been significantly enhanced to include diffuse infrared wireless LAN's as well as wireless infrared telecommunication systems for voice and data.

The technology and resulting commercial products are reviewed.

INTRODUCTION

Diffuse infrared communications is a powerful, well established wireless technology which has greatly benefited by recent advances. Since 1979, Wilton's sole specialty has been diffuse infrared communications. Former limitations of infrared communication such as the need for a direct line-of-sight have been eliminated by new techniques. Currently, increasing numbers of system designers wishing to eliminate cables are discovering this unfamiliar technology.

Several wireless communication systems have been developed in a series of projects completed by Wilton for NASA Johnson Space Center. Included are infrared wireless systems that provide multi-channel, multi-user communications for both voice and data. The high speed, digital design of these systems provides the flexibility to configure wireless networks to handle voice, data or a combination of both at the same time.

Wilton's diffuse infrared technology has been significantly enhanced through its NASA related activity and as a result, new wireless tools are being made available to industry.

This paper describes the nature of diffuse infrared communications, the developments related to the Wilton/NASA activity and the resulting commercial products and technology that Wilton is offering to industry.

DIFFUSE INFRARED COMMUNICATIONS DEVELOPMENT

Early Development Work

For many years, wireless communication using infrared light has been implemented using modulated infrared light beams which linked the transmitter to the receiver. If the beam was broken by an obstruction, communication was interrupted. With the commercial availability of infrared light emitting diodes and low noise photo diodes, it became feasible to construct very sensitive IR receivers which were sensitive enough to detect indirect infrared light - light which after many reflections from surfaces within a room, reaches the receiver greatly attenuated. IR communication over indirect paths is termed "diffuse" IR communications.

This development greatly enhanced the utility of infrared as a communication medium. IR transceivers were no longer required to be stationary and pointing of the optics was no longer necessary. Communication systems could be built which were "RF like" but did not suffer from FCC regulation, electrical interference, neighboring system interference, compromised security and RF health hazards. Applications such as infrared cordless telephones and wireless handheld computers became feasible.

New problems however came with the highly sensitive IR receivers:

Σ Sources of randomly modulated infrared light (such as fluorescent lights) that once may have been considered too low in level to be of concern, were now formidable sources of IR interference. Means were needed to reject this interference.

Σ For some two way systems in which a transmitter and receiver are co-located, the local transmitter may interfere with the highly sensitive receiver. Accordingly, means were needed to reject the transmitter's interference.

Σ Portable diffuse IR transmitters required excessive battery power to reach even the most sensitive receiver. An approach was required to cover large areas or multiple rooms using low powered diffuse IR transmitters.

Wilton's work in the early eighties generated solutions to problems such as these and provided a foundation for the system development that followed.

Diffuse IR Systems

By the mid 80's, Diffuse IR systems were constructed at Wilton which permitted high quality full duplex voice or asynchronous data communications between portable battery operated transceivers.

Some of these early systems were used by Intel's Systems Group for their voice recognition quality audit systems. Many such systems were installed at Ford Motor Company by Intel. Paint inspectors wearing IR voice transceivers verbally enter inspection data directly into Ford's database. The inspectors walk freely within the 40 by 160 foot inspection area. Full duplex, noise free voice communication is provided in spite of banks of high intensity fluorescent lights that are needed for visual inspection. The inspector's belt mounted IR transceivers also provide a channel for a handheld bar code scanner. Up to four such systems could be used simultaneously in the same area.

In 1987, Engineers at NASA Johnson Space Center concluded that Wilton's technology had promise for applications aboard spacecraft given additional development. An enhanced version of Wilton's voice system was developed and flown on Discovery, September 1988. NASA. At that point it was decided to move the technology to the next level.

NASA JSC/Wilton Activity

The Discovery experiment had proved the utility of Infrared communications in spacecraft. Wilton proposed a new system which would provide a means to wirelessly interconnect people and devices by a general purpose, multi-user, multi-channel communication system. Wilton won Phase I and Phase II contracts with NASA JSC through the Small Business Innovative Research Program, which resulted in the delivery of equipment June 30, 1992.

The new multi-user wireless interconnect system was based on a diffuse infrared wireless local area network (IRplex 7000), which can accommodate up to 64 wireless nodes. The network data rate is 2 Mbs with a throughput of 1.8 Mbs. Because of its deterministic design, the IRplex 7000 wireless LAN is able to handle digitized voice as well as other digitized data. As a result, special wireless nodes have been configured for voice, asynchronous data, and digitized physiological data at 160 Kbs. Interfaces to standard LANs such as Ethernet are being explored.

Wilton's previous technology for wireless asynchronous data was enhanced and prepared for commercial packaging with the help of funding from the Technology Utilization Office at NASA JSC. Exhibits show advance product sheets for the IRplex 1000 and IRplex 3100 product lines which describe the results of this effort.

Also aided by this program was the conversion of IRplex 7000 technology into a general purpose computer LAN (Wilton's IRplex 6000). This diffuse, wireless LAN operates at 2.5 Mbs and can readily be employed by any computer having a standard ARCNET adapter installed. This activity has resulted in IRplex 7000 technology being converted for use in the commercial market place.

Wilton's Commercial Activity

Wilton is moving forward in several commercial areas related to wireless infrared technology:

WILTON'S INFRARED CORDLESS TELEPHONE

- Σ SINGLE ROOM OR MULTIPLE ROOM COVERAGE
- Σ HIGH QUALITY VOICE TRANSMISSION DUE TO GENEROUS BANDWIDTH.
- Σ INTERFERENCE FREE.
- Σ SECURE.
- Σ NO DANGER OF MUTUAL INTERFERENCE IN HIGH DENSITY MULTI-OFFICE APPLICATIONS.
- Σ SUITABLE FOR BUSINESS USE

FACTORY FLOOR WIRELESS VOICE COMMUNICATION SYSTEM

- Σ INTEL COMBINED WILTON'S FULL DUPLEX IR VOICE SYSTEM WITH INTEL'S VOICE RECOGNITION SYSTEM.
- Σ PAINT INSPECTORS AT FORD ENTER DATA VERBALLY INTO FORD'S DATABASE.
- Σ IR COVERS A 40 BY 160 FOOT INSPECTION AREA. FOUR CHANNELS AVAILABLE.

Σ ROBUST OPERATION IN PRESENCE OF INTENSE FLORESCENT LIGHTING.

Σ BAR CODE SCANNER CHANNEL

WILTON'S PRESENT COMMERCIAL ACTIVITY

Σ IRplex 6000 WIRELESS ARCNET (PRE-INTRODUCTION).

Σ IRplex 1000, IRplex 3100 ASYNCHRONOUS WIRELESS PORTS WITH MULTI-ROOM COVERAGE (PRE-INTRODUCTION).

Σ IRplex 2500 CENTRAL OFFICE TALK/TEST SYSTEM .

Σ INFRARED BADGES FOR PERSONNEL LOCATION.

Σ IR WATTHOUR METER/LOGGER FOR REMOTE READING (BEING SUPPLIED TO A POWER UTILITY)

Conclusion

Wireless communication is proving to be the technology of choice for wireless application ranging from space to commercial telecommunications. With the current trend toward miniature cordless telephone and computers, the need for wireless communications has exceeded the available radio spectrum.

Wireless infrared communications, by merit of its cellular nature, can offer gigabauds of simultaneous wireless communications within a single building. The NASA/Wilton activity has made available attractive wireless solutions for both space and terrestrial use and for both government and commercial markets.

It is likely that by 2002, standard IR ports will be commonplace on most telephone and computer related devices.